

REMARKS

File History

Following the final Office action of 5/19/2005, an Advisory Action was mailed 8/29/2006 that persists with the following allowances, rejections, objections, requirements and other actions:

- **Claims 4-10** are indicated to contain allowable subject matter.
- **Claims 1, 3, 13-17, 21-22** were rejected under 35 USC §102 as being fully anticipated by **Tsai et al.** (US 5,753,418).
- **Claims 1-3, 11-16, 21-26, 34-35, 37** were rejected under 35 USC §103(a) as being obvious over **Hui et al.** (US 6,514,868) as combined with **Tsai.**
- **Claims 17-20, 36** were rejected under 35 USC §103(a) as being obvious over **Hui et al.** (as apparently combined with **Tsai** and further) as combined with **Chien** (US Pub. 2002/0142610 of Oct. 3, 2002).
- **Claims 23-26** were rejected under 35 USC §112, paragraph 2 for being unclear.

Telephone Interview of August 9, 2006

In a brief set of telephone exchanges on or before August 9, 2006, the Examiner confirmed that the rejection against Claims 17-20, 36 is indeed based on a combination of three (3) references: Tsai, Hui and Chien.

The Examiner also provided a clearer explanation of his objections to Claim 23. Applicant thanks the Examiner for his patience and courtesy. It is proposed to amend Claim 23 as shown above to address the Examiner's objections.

Subsequent Advisory Action

In the Advisory Action of 8/29/2006 following Applicant's response of August 14, 2006, additional positions appear to have been set forth by the PTO as follows. (Correction is respectfully requested if this is not accurate since some of the language from the Advisory continuation sheet has been paraphrased for better readability.)

1. No patentable weight was given to Applicant's arguments regarding the recitation of forming vias through an InterLayer Dielectric region (ILD) of a monolithically integrated device for a contact forming method (as occurs in Claim 1 --and in Claim 34 according to the Advisory?) **because the recitation occurs in the preamble** and the preamble is generally not accorded any patentable weight.

2. The Examiner found that the Tsai '418 teaching of the aperture size to **"as narrow as about 0.3 microns"** is not limiting and does not teach away from considering forming apertures of smaller dimensions.

3. Regarding Claim 3, and although Tsai might be silent about his CF4 constituting a source of etch inhibitor which selectively adheres to organic surfaces, the PTO found that it is nonetheless a fluorocarbon species that forms part of Tsai's etchant where the etchant appears to behave similarly to that of the claimed invention, and thus Tsai's CF4 would [**inherently**] also provide source of etch inhibitor which selectively adheres to organic surfaces. [*Bracketed language added*].

4. At the time of the invention, the PTO found, the use of any of these ARC materials (**organic** or **inorganic**) [**interchangeably**] would be obvious and either would produce an expected result of reducing the light reflected from the substrate. Accordingly, Applicant's argument's that Hui describes inorganic ARC having "reflective properties" was noticed by the examiner but was found not persuasive. [*Bracketed language and emphasis added*].

5. It was agreed by the PTO that Tsai '418 doesn't teach the step of filling the contact holes with an electrical conductor and Chien doesn't provide tapered ARC. However, in response to applicant's arguments, the PTO found that these arguments are made only against the references taken individually and one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*.

6. With regard to Claims 23-26, the PTO found that the methods of Hui or Tsai would [**inherently**] provide different plug spacings and/or spacings between conductive lines due to process variation.

7. The PTO noted that there is no rejection over the combination of just Tsai and Chien. Applicant's argument about Chien and Tsai was acknowledged but deemed of no consequence.

8. The PTO asserted that the motivation for combining Hui and Chien is to etch the silicon dioxide with a high selectivity to the under or lower layer such as silicon nitride layer. Applicant has not convincingly traversed this reason for combining.

Summary of Current Response

Claims 4, 5, 8, 23 and 26 are amended.

Claim 38-41 are newly submitted.

A Rule 132 Declaration is submitted in support of factual assertions made in the present Request for Continued Examination (RCE).

Attorney arguments are presented in conjunction with the Rule 132 Declaration concerning the art of record and its proposed combination and/or modification.

Note re Claims 4-10

Claims 4-10 were indicated to contain allowable subject matter in the last action. However in review of those claims Applicant noticed that they said "carbohydrate" whereas the intent was "hydrocarbon". This is corrected in the amendments above.

Applicants' Overview of Outstanding Office/Advisory Actions

Applicant sees the final Office action of 5/19/2006 and the subsequent Advisory Action as having the following noteworthy features (1)-(3):

(1) The PTO refuses to credit the preamble of Claim 1 with patentable weight. Applicant respectfully submits that this is legal error. Paragraph (a) of Claim 1 makes antecedent reference to "the ILD". Per Bell Communications --a Fed. Cir decision cited below-- when the body of a claim makes antecedent reference to the preamble, that reference makes the preamble a necessary part of the claim. There is no ILD or a yet-formed IC active layer in Tsai '418. All the layers from pad oxide 12 on the bottom up to ARC layer 16 are sacrificial and are stripped away in the process of forming FOX regions 12a-12b as seen in Fig. 6. Thus Tsai '418 cannot be reasonably seen as anticipating the claimed subject matter.

(2) Moreover, in Tsai '418 the photoresist (PR 18) is thick {8000Å in the Example of col. 10} and the to-be-etched dielectric (SiN 14) is thin {1700Å in the Example of col. 10}. The photoresist (PR 18) is responsive to 365nm light (NUV) to produce apertures no smaller than about 0.3 microns {actually 0.36 microns in the Example of col. 10}. These factors significantly affect what is possible or not as is detailed in the accompanying Rule 132 Declaration. A skilled artisan would not be motivated to take any photoresist (PR) of any arbitrary thickness and to use Tsai's method as such with a reasonable expectation that Tsai's method would reliably form apertures substantially smaller than the stated limited of "as narrow as about 0.3 microns" (3000 Å). The skilled artisan would appreciate that Tsai teaches an aspect ratio between PR thickness and aperture width of roughly 8-to-3 (=8000Å/3000Å). The skilled artisan would appreciate that one cannot expect to succeed with a plan to use arbitrarily thin apertures etched through arbitrarily thick PR layers.

(3) The PTO continues to find that organic and inorganic ARC's are equivalent and interchangeable. This is factually incorrect. The point is addressed in greater detail in the accompanying Rule 132 Declaration. Applicant persists in the argument that Tsai's ARC is "anti-reflective" organic and thus the antithesis of Hui's "reflective" inorganic ARC because the functions are different. Reflective (inorganic) ARC's operate by way of phase shifting and cancellation via interference. Organics operate by optical absorption. A reflective inorganic ARC layer cannot be made to have an arbitrary thickness because then its phase shifting and cancellation properties would be jeopardized. The accompanying Rule 132 Declaration

explains this. The accompanying Rule 132 Declaration also explains why Hui and Tsai teach away from one another on a number of different levels. Not only are the optical functions substantially different, so are the chemical and mechanical properties. It is noted moreover here that the inorganic silicon nitride of Hui 6,514,868 cannot operatively serve as an etch mask for Tsai's silicon nitride target layer because the same material cannot be its own etch mask. That is additional argument for why the ARC's are not interchangeable.

Applicant's Reading of the Tsai '418 reference

Tsai '418 forms the foundation of a majority of the art-based rejections. The Title of Tsai '418 calls for a 0.3 micron aperture which by itself would dissuade artisans from thinking that Tsai's techniques can be practiced for smaller dimensions. Tsai's scope language at col. 5, lines 44-61 limits the aperture size to "as narrow as about 0.30 microns" (line 54) thus guiding artisans away from considering such a technique for smaller dimensions. Applicant and Examiner appear to disagree on this issue of fact. The accompanying Rule 132 Declaration buttressed Applicant's position by showing that formation of densely packed contact vias is not the same as formation of field oxide. Reconsideration is respectfully requested.

As spelled out in the accompanying Rule 132 Declaration (see paragraph 4m), the aspect ratio between aperture size and photoresist thickness cannot be arbitrarily picked. Smaller apertures call for thinner photoresists due to aspect ratio considerations and the need to assure that the hole will remain open. An arbitrarily thick PR may not be able to sustain an arbitrarily narrow opening therethrough. On the other hand, an arbitrarily thin organic photoresist may not be capable of enduring prolonged attack by an etchant, particularly if the depth of etch is a large one. This is why Tsai's SiN layer 14 is thin and his photoresist is thick.

More specifically, in the only example given; at col. 10 of Tsai '418; the SiN layer is just 1700Å (0.17micron; per col. 10, line 16). The organic ARC layer 14 is 1500Å (0.15 micron; per col. 10, line 32). The overlying, photosensitive layer 18 is much thicker, 8000Å (0.8 micron; per col. 10, line 36) and capable of forming apertures no narrower than about 0.36 micron (3600Å per col. 10, line 39) WHICH IS WHY the tapered ARC technique of Tsai is used in the first place to reduce the width down to about, but no narrower than 0.32 micron (3200Å per col. 10, line 62). If it were possible to make narrower apertures with the 8000Å

thick PR of Tsai '418, common sense would tell us that Tsai could have done so directly instead of going through the bother of his specialized two-step process (CF4 plus Ar at col. 10 lines 42-54 to form the tapered ARC, followed by CF4 plus CHF3 at col. 11 lines 1-12 to etch through the thin SiN).

Per the accompanying Rule 132 Declaration (see paragraph 4L), the 8000Å thickness of the photoresist (PR) is an apparently necessary condition for forming and preserving the ARC taper during Tsai's specialized two-step process (CF4 plus Ar at col. 10 lines 42-54 to form the tapered ARC, followed by CF4 plus CHF3 at col. 11 lines 1-12 to etch through the thin SiN). It wouldn't work with a substantially thinner PR and the apertures could not be made substantially smaller than the stated "about 0.3 microns" unless the PR is made thinner. Thus, Tsai '418 is bound to the "about 0.3 microns" as his lower limit of enablement. It is not a number that would be arbitrarily overlooked by ordinary artisans.

Unexpected Results Demonstrated in this Application

Note Fig. 3B of the present application. This constitutes "evidence" that AEI (After Etch Inspection) aperture widths do not inherently go down --especially for the small width and Densely packed vias (squares plot)-- relative to ADI (After Development Inspection) aperture widths when tapering is attempted. Note from the plot formed by the squares in Fig. 3B that the observed average aperture sizes (AEI's) at the 5/1 and 3/1 mix ratios was greater than the initial ADI value of about 0.15µm. See application paragraphs [0063]-[0067]. Fig. 3B demonstrates that significant amounts of experimentation may be required to find an etch recipe (chemicals plus mixture ratio) that provides reliable size reduction (a small min-max spread). Note further, paragraph 4i of the accompanying Rule 132 Declaration where the expert supports the assertion of unexpected results.

Referring to Tsai Fig. 6, it is clear from this that Tsai's goal is not that of forming contact apertures that may be densely packed. In Tsai Fig. 6, the sacrificial layers 12 (pad oxide--very thin and not etched through), 14 (thermal oxidation mask SiN with negative etch bias, --see col. 2, line 46), 16 (ARC material with superseding positive taper characteristics --see col. 8, line 61) and 18 (photoresist) have all been removed to leave behind only the regularly spaced apart field-oxide regions (FOX) 12a, 12b and the silicon substrate 10'. At this stage, the silicon substrate 10' has no active device regions in it. (Note that Claim 2 of the present application calls for active regions.)

The outstanding grounds of rejection assume that the ordinary artisan would ignore all these factors and would see Tsai '418 as teaching an ARC tapering method of applicability to any, and operability to every kind of situation, including that of forming densely-packed contact holes through thick oxide ILD to an underlying, active device layer.

However, as explained in the Rule 132 Declaration (see paragraph 4j), Tsai has nothing to do with forming densely packed contacts to an active layer for a number of reasons.

Tsai teaches to not etch through oxide. This alone teaches away from the idea that his technology should be used when patterning an Inter-Layer Dielectric region (ILD) that is to be interposed between first and second conductive layers of a monolithically integrated device. As explained in the accompanying Rule 132 Declaration, an ILD will be oxide based rather than nitride based because the general desire is to reduce capacitive coupling between conductive layers.

Preamble of Claim 1 must be given Patentable Weight

Paragraph (a) of Claim 1 makes antecedent reference to the preamble. As a result, the preamble of Claim 1 must be given patentable weight. It is well established that a preamble of a claim is part of its limitations if the body makes antecedent reference to the preamble and thus causes the preamble to be a necessary part of the claim. See Bell Communications Research, Inc. v. Vitalink Communications Corp., 55 F.3d 615, 620 (Fed. Cir. 1995). See also Eaton Corp. v. Rockwell Int'l Corp., 323 F.3d 1332, 1339 (Fed. Cir. 2003). It is also well established that there are no per se rules about preambles. See Catalina Mktg. Int'l, Inc. v. Coolsavings.com, Inc., 289 F.3d 801, 808 (Fed. Cir. 2002). See Storage Tech. Corp. v. Cisco Sys., Inc., 329 F.3d 823, 831 (Fed. Cir. 2003) {"whether to treat a preamble as a claim limitation is determined on the facts of each case in light of the claim as a whole and the invention described in the patent." } Thus the determination in the final Office action based on Kropa v. Robie (CCPA 1951) is antiquated and not in accordance with current law.

The preamble of Claim 1 calls for: "forming vias through an interlayer dielectric region of a monolithically integrated device where the interlayer dielectric region (ILD) is structured to separate a first conductive layer from a second conductive layer of the

monolithically integrated device, ..." [*Emphasis added.*] Once again, paragraph (a) of Claim 1 makes antecedent reference to the preamble and therefore the preamble cannot be ignored.

Tsai '418 teaches away from use of his ARC tapering method in modern fabrication because Tsai teaches to use his technology only for "as narrow as" 0.3 micron (thus teaching away from narrower) and also because Tsai teaches to completely strip away the thermal oxidation masking layer (SiN layer 14) before any active devices are formed (col. 9, line 63) and to also partially strip away the underlying pad oxide layer 12 (col. 9, line 65). Thus in Tsai there is no interlayer dielectric (ILD) region of a monolithically integrated device.

With regard to Claim 2, it is clear that an active devices layer is not present in Tsai '418. An active devices layer implies that contact holes may have to be densely packed depending on how sources and drains of transistors are laid out. See for example, items 112, 114 in Fig. 1 of the present application.

With regard to Claim 3, there is no factual basis for postulating that CF₄ constitutes a source of etch inhibitor which selectively adheres to organic surfaces. Inherency may not be established on the basis of conjecture.

With regard to Claims 11-12, note that Tsai '418 limits his apertures to as narrow as about 0.30 micron, thus teaching away from the smaller dimensions of Claims 11-12.

With regard to Claims 13-16, the problem is that Tsai has no ILD in which the recited third openings can be formed. Claim 13 depends from Claim 1 and the body of the latter makes antecedent reference to its preamble.

Applicant's Reading of the Hui reference

Hui '868 forms the foundation of art-based §103/102(e) rejections against claims 1-3, 11-16, 21-26, 34-35, 37 and 17-20, 36.

The rational for combining Hui '868 with Tsai '418 is given at OA page 4, lines 7-13 as "Unlike claimed invention, Hui doesn't describe ... organic [**anti-reflective**] ARC. ... One skilled in the art ... would find it obvious to use any other ARC including organic ... because

Hui teaches that the ARC can be any other suitable material having reflective properties" [*Emphasis and bracketed text added.*]

Note that the original rejection language left out the fact that Hui's ARC is of an "anti-reflective" inorganic composition. Applicant respectfully submits that the above basis of rejection inherently contradicts itself. It admits that Hui calls for ARC's having "**reflective properties**". That teaching cannot logically cover "all" ARC's since it limits itself to reflective ones. Most especially it cannot logically cover the ARC's of Tsai '418 which are expressly referred to as "organic anti-reflective coating (ARC)" (Abstract, and see also col. 2, line 13). A person of skill would appreciate that organic chemistries are different than inorganic chemistries and that optically absorbing ARC's are different from the phase-shift-based canceling ARC's taught by Hui. Tsai and Hui clearly teach in diametrically different directions. This argument is clearly supported by the accompanying Rule 132 Declaration.

The Advisory Action of 8/29/2006 counters that all ARC's will have some amount of reflectivity. Applicant respectfully submits that such is not at all the issue. Skilled artisans understand that there are two mutually exclusive types of ARC's, organic ones and inorganic ones. The organic and inorganic ARC's have substantially different optical properties; substantially different chemical properties and substantially different mechanical properties. They are not arbitrarily interchangeable. For example, it would not be possible to replace the organic ARC 16 of Tsai '418 with an ARC composed of silicon nitride because the layer 14 that is to be patterned is itself silicon nitride. The etch recipe that eats through the lower silicon nitride layer 14 would also eat through the ARC mask (if SiN is used to define layer 16) and in that case layer 16 would no longer function as a mask. Moreover the nitride-eroding chemistry that is used to open up holes in the ARC mask (if SiN is used to define layer 16) would eat into layer 14 (also SiN) and thus fail to reproduce the intermediate structure of Tsai Fig. 2. Applicant's position is buttressed by the accompanying Rule 132 Declaration which explains why organic and inorganic ARC's are not interchangeable.

It is well established that references which teach away from one another cannot be combined. Hui and Tsai clearly teach away from one another.

(As an aside, Applicant continues to reserve the right to attack the use of Hui as a prior art reference under the legal fiction of 35 USC §102(e). 102(e) requires a §112 level of description. For example, Hui admits at col. 4, line 30 that the "exemplary" embodiments are

preferred ones while not providing any details re recipes and so forth for the supposedly performed examples. Thus there is a question whether Hui satisfies all the requirements of 35 USC §112.)

Re Claim 34, this is for a "contact forming method" and even if the preamble is ignored, one cannot ignore recitation in step of "(d) filling the substantially vertical contact holes with an electrical conductor". Tsai '418 does not teach a contact hole filled with conductor. Tsai teaches an oxidation hole whose void is replaced by growth of insulative oxide. This is opposite to forming a conductively-filled via. Irrespective of the weight accorded to the preamble, Claim 34 affirmatively recites "(d) filling the substantially vertical contact holes with an electrical conductor." Tsai undeniably teaches to grow insulative oxide in the position of the formed aperture.

Re Claim 26, the recited "different plug spacings and/or different spacings between corresponding conductive lines" are not inherent to Hui or Tsai. It is not understood how the PTO can use pages 7-8 of the present application (detailed Description) against Applicant at page 6 of the OA. The Advisory Action of 8/29/2006 counters that process variation would create holes of different sizes. Claim 26/25/24/23/1 calls for use of the method of Claim 1.

Claims 17-20, 36 rejected in view of Tsai '418 combined with Hui and further combined with Chien '610

No rational is given at OA page 6 for combining Hui '868 --first with Tsai '418 as confirmed via telephone by the Examiner-- and then further with Chien '610. As already argued above, Tsai '418 teaches an anti-reflective organic ARC. Hui teaches a reflective inorganic ARC (silicon nitride). Thus they teach away from each other and cannot be fairly combined.

Chien '610 calls for the combination of a silicon nitride etch stop layer (page 1, paragraph [0010]) and a silicon oxide dielectric layer disposed over the etch stop (paragraph [0011]). In Fig. 1A, layer 106 is the SiN etch stop (paragraph [0025]). Layer 114 is the silicon oxide dielectric layer (paragraph [0026]). As seen in Fig. 1C, Chien teaches to retain the insulative silicon nitride 122 over the gate 104 (see paragraph [0025]) so as to thereby provide a contact hole that is smaller at its bottom than at its top. From this, it is seen that Chien teaches a hole tapering technique entirely different from that of Tsai '418. Thus it may be said that Chien and Tsai teach away from one another. Thus we have three references that teach one away from the other: Tsai, Hui and Chien. (Note that the accompanying Rule 132 Declaration briefly discusses Chien near the end of the declaration.)

The etch recipe that Chien provides at [0041]-[0042] is employed for selective etching of the oxide material (114) in preference over etching of the nitride etch-stop material (122, 106). See Chien paragraph [0038]. In this, Chien teaches away from Tsai '418 because layer 14 of Tsai is silicon nitride and Chien's recipe is formulated specifically to not etch through nitride. Chien also teaches away from Hui because Hui directs the artisan to etch straight through to the substrate 12 whereas Chien teaches to stop at a nitride etch stop layer 106. Chien does not disclose what "subsequent etch" ([0026]) is to be used for removing the silicon nitride in transitioning from Fig. 1B to 1C and thereby achieving the claimed 0.25 micron contact dimension. Thus Chien may be non-enabling in this respect.

With regard to arbitrary picking and choosing of etch chemistries, such as is done at OA page 7, paragraph 5, please note that Hui teaches a silicon nitride hard mask with no PR on top. Chien uses conventional photoresist (layer 116, see paragraph [0026] and no hard mask on top. The choice of materials to be used in an etch is dependent on the totality of the chemical and energetic plasma environment. A person of skill in the art would not arbitrarily choose any and all chemical compositions in accordance with mere whim. That is not reasonable.

Re claim 36, there is no showing that Chien's etch process generates tapered ARC openings.

Indefiniteness rejection

An indefiniteness rejection is appropriate when the PTO can demonstrate that a person skilled in the art would have no reasonable way of determining the metes and bounds of the claim.

Applicant thanks the Examiner for explaining his objections to Claim 23. It is believed that the above changes to Claim 23 overcome the Examiner's objection.

Please note that paragraph (e) Claim 23 recites "using a predefined photomask to define width dimensions of the first openings". This clearly makes antecedent reference to the first openings of the first integrated device (the one mentioned in the preamble). It is proposed to clarify paragraph (f) of Claim 23 by reciting "using the same predefined photomask to manufacture additional monolithically integrated devices" [*Emphasis added.*]. This clarifies that a further limitation is that of using the same photomask as used in manufacturing the integrated device of the preamble to manufacture additional integrated devices.

With regard to the actual indefiniteness rejection, it is respectfully submitted that one skilled in the art will not be confused about scope. Either one engages in "using the same predefined photomask to manufacture additional monolithically integrated devices" or not. There is nothing indefinite about that. Either each of the manufactured integrated devices is either one "each having a respective version of said ILD region" or not. There is nothing indefinite about that. Either each of the manufactured devices is one "each having a respective version ... of said photoresist layer" or not. There is nothing indefinite about that. Either each of the manufactured IC is one "each having a respective version ... of said ARC layer with inwardly-tapered openings" or not. There is nothing indefinite about that. Either "at least two of the monolithically integrated devices that are manufactured by use of said same predefined photomask have differently dimensioned widths for their corresponding, third openings" or not. There is nothing indefinite about that. So Applicant fails to see what is indefinite about the claim. Clarification is respectfully requested if the Examiner continues to object to Claim 23.

CONCLUSION

It is believed that all outstanding grounds of rejection have been overcome or traversed in light of the foregoing arguments and the accompanying Rule 132 Declaration. Applicant respectfully requests entry of the amendments and examination with favorable outcome. Should any other action be contemplated by the Examiner, it is respectfully requested that he contact the undersigned at (408) 392-9250 to discuss the application.

A two month extension of time is requested. The Commissioner is authorized to charge any underpayment or credit any overpayment to Deposit Account No. 50-2257 for any matter in connection with this response, including any fee for extension of time and/or fee for additional claims, which may be required.

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class Mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on __October 19 __, 2006.

 10/18/2006

Attorney for Applicant(s)

Date of Signature

Respectfully submitted,



Gideon Gimlan
Attorney for Applicants
Reg. No. 31,955

MacPherson Kwok Chen & Heid LLP
2033 Gateway Place, Suite 400
San Jose, CA 95110
Tel: (408) 392-9250

MacPherson Kwok Chen & Heid
LLP
2033 Gateway Place,
Suite 400
San Jose, CA 95110
Telephone: (408) 392-9250
Facsimile: (408) 392-9262